USER STORY

Broadcom Develops Low-Cost 3G Semiconductor Product with MathWorks Tools

THE CHALLENGE

To develop a low-cost semiconductor product based on 3G standards that handset manufacturers could combine with chips based on 2G standards

THE SOLUTION

Use MathWorks tools to develop algorithms and model the chip subsystems

THE RESULTS

- Chip saves manufacturers millions of dollars
- Models reused for production release
- Development time cut in half

The introduction of 3G standards, such as WCDMA, increased data rates and improved voice quality to mobile and portable wireless devices. To support WCDMA as well as existing 2G standards, such as GSM/GPRS, mobile smart phone manufacturers faced the challenges of getting to market quickly while keeping development and component costs to a minimum.

With MathWorks products, Broadcom (formerly Zyray Wireless) used Model-Based Design to accelerate the development of the SPINNER family of WCDMA semiconductor products for 3G mobile devices. An add-on WCDMA baseband processor based on patented Space-Time Processing technology, SPINNERchip enabled handset manufacturers to develop cost-effective dual-mode devices by using existing components for the GSM/GPRS functionality and SPINNERchip for the WCDMA functionality.

"With MathWorks tools, we were able to get to market fast with our family of WCDMA products and deliver a two-chip solution that enables handset manufacturers to reduce costs substantially," explains Larissa Kogan, marketing manager.

THE CHALLENGE

WCDMA was much more complicated than GSM. "The main challenge is translating the sheer complexity of the WCDMA system into a functioning piece of hardware," says Mark Kent, director of systems engineering.

Because Zyray Wireless was a relatively new company before it was acquired by Broadcom, it had to establish credibility by proving that it could release a product to market on time—within two years. To meet this goal, it needed

SPINNER*chip* add-on WCDMA baseband processor.

the software design to map closely to what would be implemented in hardware.

THE SOLUTION

Beginning their design flow with MATLAB® and Simulink®, Broadcom engineers implemented a WCDMA-based chip that handset manufacturers could integrate with their 2G chips.

After reviewing and interpreting the WCDMA specification, Broadcom engineers used MATLAB to develop a rake receiver algorithm, as well as algorithms for filter transmission and reception, multipath searching, and forward error-control coding. They used the visualization capabilities of MATLAB to review the algorithms and signals before performing spectral analysis to validate that the signals met the specification.

"The analysis, visualization, and data handling capabilities of MATLAB made validating the functionality and performance much easier," says Francis Swarts, systems engineer. "I just don't know how you would do this kind of work in anything but MATLAB."

Working in Simulink, engineers then modeled and validated the specifications

against their requirements. After algorithm development and validation, they wrote custom blocks in procedural code using Simulink S-functions. They used MATLAB and Simulink to model various subsystems, including the base station, a wireless channel model, and the handset. Each subsystem served as a unit test harness for the others. With Simulink, they quickly partitioned the behavior into architectural subsystems to enable the hardware designers to implement each piece more easily.

They then generated test vectors from custom Simulink blocks and verified them against the vectors that the hardware designers had written in VHDL. "Our hardware engineers use Simulink blocks as the basis for what they need to write in VHDL," explains Swarts. "These provide great guidance to our hardware engineers."

Using Simulink, Broadcom engineers encapsulated their handwritten C code for easier management, reuse, and incorporation into the model. At the implementation level, they used MATLAB to perform further analysis on the simulation data.

"Designing the entire infrastructure of the simulation in raw C would have been a near impossibility," says Swarts. "With MATLAB, you can build vectors of signals and perform partitioning within a couple of lines of statements, then use Simulink to determine a hardware-efficient way of performing the processing."

Broadcom implemented the hardware using downstream ASIC design and implementation tools.

With the release of SPINNER*chip*1.1, Broadcom became one of the first companies to release a coprocessor solution.

> *"MATLAB is an ideal environment for developing and understanding our algorithms. Simulink integrates well with MATLAB and lets us produce a design that looks very similar to what we end up with ultimately in hardware."*
>
> **Francis Swarts, Broadcom**

Infineon Semiconductor adopted SPINNER*chip* (WCDMA) within its 2G platform (GSM, GPRS, EDGE) to enable manufacturers to develop handsets quickly and more cost-effectively.

THE RESULTS

- **Chip saves manufacturers millions of dollars.** Using MATLAB and Simulink, Broadcom produced a chip that provides manufacturers with savings of $10 to $20 over competing single-chip implementations and $2 million to $3 million per project in development savings.
- **Models reused for production release.** Broadcom reused the core blocks of version 1.0 to help with the production release of the product, version 1.1. "The Simulink blocks that we created will form the basis and timeline for future enhancements," says Swarts.
- **Development time cut in half.** "Programming everything in C would have been at least a doubling of effort because we would not have had the ease of looking at algorithms quickly in MATLAB," explains Swarts. "We would have had to hand code everything just to get the initial idea of how well things were working. And to get it closer to a hardware architecture would have required another complete recoding."

To learn more about Broadcom, visit *www.broadcom.com*.

APPLICATION AREAS

- Communications
- Model-Based Design
- Algorithm development
- R&D
- Semiconductors
- Simulation

PRODUCTS USED

- MATLAB®
- Simulink®

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